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One rule does not fit it all: patterns and drivers of stakeholders perspectives of the endangered Iberian wolf

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Abstract

Public attitudes are vital for the successful implementation of management strategies and conservation programs. However, contradictory interests among different stakeholders can create important setbacks, creating barriers to achieve conservation goals. The endangered Iberian wolf (*Canis lupus signatus*) occupies now only 20% of its historical distribution area, in Portugal, and its reduction was mostly due to direct human persecution. Here, we assessed locals' attitudes towards the Iberian wolf in northeast Portugal, in a region where humans and wolves coexist for centuries. A total of 323 questionnaires from three different interest groups (general public, livestock owners and hunters) were analysed. We tested the differences in attitude and fear level patterns between the different groups and assessed what socio-demographic factors could be influencing the detected patterns. We found that general attitude towards this carnivore was neutral to positive, probably owing to the low levels of livestock predation and long coexistence with local populations. However, most drivers differed among stakeholders groups. Education, knowledge, and level of fear were strong predictors explaining attitudes towards this endangered species. We stress the importance of assessing attitudes patterns and identifying the socio-psychological factors as necessary tools to facilitate the development of targeted tolerance-promoting strategies. Among other instruments, increasing locals' tolerance toward the Iberian wolf can be achieved by target education interventions, where the stakeholders can actively take part in discussions to accommodate their needs and expectation, rather than be listeners of the implemented programs.

Keywords: Iberian wolf, *Canis lupus signatus*, human dimensions, human-carnivore conflict, wolf conservation.

1. Introduction

Biodiversity conservation changed as a paradigm in the last decades, moving from a framework focused on protecting wilderness and protected areas *per se* into a framework that includes the human dimension (Mace, 2014). While doing so, conflicts between conservation and human activities and interests have been perceived as determinants of the success of conservation initiatives (Redpath et al., 2013). There are several examples that highlight the importance of acknowledging the social-ecological dimension of human-wildlife conflicts in solving conservation problems (Bennett et al., 2017). In this scenario, contradictory interests between different stakeholders is an obstacle to achieve efficient conservation and mitigation measures (Colvin et al., 2015) and is one of the main reasons why human-wildlife conflicts are so complex and difficult to solve (St. John et al. 2018). In fact, even the framing of the conflict itself is intricate, as several authors suggest two components of the conflict (Bennett et al., 2001; Marshall et al., 2007; Young et al., 2010; Redpath et al., 2013): i) human-wildlife conflict; and, ii) human-human conflict which reflects "*situations that arise when two or more parties have strongly held views over biodiversity objectives and one of those parties is attempting to assert its interests at the expense of the other"* (Redpath et al., 2014). Therefore, conflicts are between people with contradictory interests on wildlife species (Redpath et al., 2014) and peoples' tolerance to carnivores are influenced by attitudes (i.e. a psychological propensity to evaluate things, people and concepts in a favourable or disfavorable degree; Albarracin et al., 2005), behaviours (i.e. how humans act and interact to external or internal stimulus situation; St. John et al., 2010) and perceptions (i.e. how people view and understand nature; Gelcich and O'Keeffe, 2016) that are imbedded in complex cultural and social settings. The implementation of conservation programs can induce hostility and resentment in local communities if people feel external decisions are taken in which, and from which, they are excluded, leading ultimately to a resistance position (Skogen et al, 2008). Nevertheless, understanding the perceptions, knowledge, tolerance and motivations of the different stakeholders involved and/or affected is crucial to developing conservation programs' communication approaches specific to the needs and expectations of each stakeholder group (Sterling et al., 2017), to guarantee their support (Klein, 2013), and, ultimately, alongside with preventive measures to control wolf depredation, to promote coexistence between wildlife and humans (Struebig et al., 2018).

Classical examples of the human-wildlife conflicts include mammalian carnivores, especially those belonging to the families Ursidae, Canidae and Felidae (Kruuk, 2002). These are highly endangered species, with ecological adaptations that make them humans' competitors or even responsible for damages

in human structures or productions (Kruuk, 2002). Such relationship often leads to their persecution by humans (Treves and Karanth, 2003). The well-known relationship between humans and wolves is a typical example of this rooted conflict (Woodroffe et al., 2005). This species, despite having a pivotal role in shaping ecosystems (Miller et al., 2001; Ripple and Beschta, 2012), has also been considered a problematic carnivore (Mech and Boitani, 2003). The major cause of this conflict is livestock predation, which can increase human negative attitudes, leading to direct persecution (Mech and Boitani, 2003), jeopardizing conservation efforts (Treves and Karanth, 2003).

The Iberian wolf (*Canis lupus signatus*) is an endemic wolf subspecies inhabiting the Iberian Peninsula, being protected in Europe and in Portugal by law since 1988, and listed as "Endangered" in the Portuguese Red Data Book (Cabral et al., 2005). Livestock predation levels in Portugal are very high (Torres et al., 2015; Pimenta et al., 2018), triggering conflict with rural communities. Direct human persecution is one of the major outcomes of this conflict and is the main threat to the survival of this endangered species, contributing the dramatic reduction of its range (Pimenta et al., 2005). By the beginning of the last century, the Iberian wolf had a wide distribution in Portugal, but it is now restricted to natural and rural contexts, which corresponds to only 20% of its original distribution area (Álvares, 2004; Pimenta et al., 2005). So, the future of this endangered species is likely to be tightly linked to the perceptions, attitudes and behaviours of rural residents towards this canid. Yet, despite its dramatically reduction, there are some places in which the Iberian wolf continues to coexist with people, offering powerful insights on a carnivore conservation, while informing how conservation conflicts may be managed elsewhere. Such context is, therefore, a unique opportunity to investigate how these factors might foster tolerance and coexistence with this endangered species. In fact, there is increasing evidence that large carnivores can persist, and are even thrive, in human-dominated landscapes (López-Bao et al., 2017; Mancinelli et al., 2019) so elucidating the factors that can contribute to local tolerance serves as an important tool that can also be used in this humanized landscapes.

At a local scale, conservation success often depends directly on the attitudes and behaviours of local people living and working in the proximity of protected areas and wildlife (Marchini and Macdonald, 2012). Thus, identifying the role of social-economic, demographic and psychological factors in determining human tolerance and behaviour (Røskaft et al., 2007; Dickman et al., 2013) will be of great importance in accomplishing conservation goals. However, despite the rapid growth of our understanding and acknowledgement of human-wildlife relations in wildlife conservation n general (Kansky et al., 2016), and

carnivores in particular, little is known about the Iberian wolf impact on different stakeholders activities. Early studies on local perceptions of wolves in Portugal assessed the role of socio-demographic factors in human-wolf conflict (Espírito-Santo, 2006, 2007; Milheiras and Hodge, 2011; Espírito-Santo et al., 2013; Espírito-Santo and Petrucci-Fonseca, 2014) and showed that, in general, attitudes were neutral, with livestock owners generally being the least tolerant group to wolf presence. However, attitudes may not be uniform within human populations and distinct geographical regions, as different stakeholders may interact with wolf populations differently and, consequently, have distinct behaviours linked to the wolf presence. For example, while cattle owners may be directly affected (economically) by the loss of domestic animals due to predation (Muhly and Musiani, 2009), hunters may be indirectly affected by the loss of hunting opportunities (Smith and Bangs, 2009) and the general public, often more urban, whose activities do not interact with wolves, may simply ignore it (Heberlein and Ericsson 2008). It is also known that demographic factors such as age (Williams et al., 2002), gender (Kleiven et al., 2004), education level (Røskaft et al., 2007) and wealth (Zimmermann et al., 2005) can affect the degree of tolerance of the population towards this species (Klein, 2013).

Thus, to improve our understanding of the public attitudes towards the Iberian wolf in a human-dominated landscape, we evaluate the attitudes, knowledge and fear levels of human populations towards the Iberian wolf in the northern region of Portugal, where the most stable wolf packs are located (Torres and Fonseca, 2016). Here, people and wolves have coexisted for centuries and exploring the factors underlying people's perceptions of coexistence offer powerful insights into carnivores' conservation elsewhere.

Our general aim was to understand the social perceptions and attitude of different stakeholders towards the endangered Iberian wolf. We specifically aimed: (i) to evaluate how attitudes, knowledge and fear levels varied between the different stakeholders (e.g., target groups *i.e.* general public, hunters and livestock owners); and, (ii) to explore the effects of socio-demographic factors (e.g. age, gender, education), individual experiences and knowledge about the wolf ecological characteristics on the attitudes and fear levels. We hypothesize that the attitude towards the Iberian wolf and the fear levels will differ between the different target groups due to the different socio-demographic characteristics (i.e. school education level, age, gender), knowledge about the species ecology and different experiences with wolves (i.e. economical losses, negative direct experiences in the wild that may trigger (un)rational fear and negative attitudes). Furthermore, fear levels will also be a driver of the stakeholder's attitudes, as increased fear levels may

induce more negative attitudes (Dickman 2010). Our assumption is that different factors will have different effects on the attitude of each specific group. Such insight will help in understanding similarities and differences between different stakeholder groups and guide the development of appropriate conservation measures.

2. Materials and Methods

2.1 Study area

Our study was conducted in northeast Portugal, within an area of 1,173 km^2, and includes Montesinho Natural Park, a protected area relevant for the Iberian wolf conservation. It is a mountainous region with elevations ranging from 438 to 1,481 m and a climate mainly of Mediterranean type, with an Atlantic and continental influence. The forest is mainly composed of deciduous forests, dominated by oaks (*Quercus pyrenaica, Q. faginea, Q. rotundifolia, Q. suber*), and chestnut (*Castanea sativa*), and pines (*Pinus pinaster*). In some regions Mediterranean shrublands dominate the landscape, composed mainly by *Erica* spp., *Cytisus* spp., *Genista* spp., *Ulex europaeus, U. minor*, *Cistus ladanifer* and *Chamaespartium tridentatum* (Valente et al., 2014). This area is predominantly rural, consisting of small villages and a main city (Bragança) with a relatively low human density of 29 hab/km^2 (INE, 2016), and the main economic activities of this region are agriculture, forestry and livestock production (Rosa, 2006). According to Pimenta et al. (2005), the Bragança wolf nucleus includes 20 confirmed packs and 5 probable packs, some overlapping the study area. In this area, there is also a high density and diversity of wild ungulates namely wild boar (*Sus scrofa)*, roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) (Santos, 2009; Valente et al., 2014; Torres et al., 2015). The diet of the wolf population nucleus present in this region is mostly based on the consumption of those wild species but on some occasions also on domestic animals (Álvares, 2004; Figueiredo et al., 2020).

2.2 Data collection

We developed a semi-structured questionnaire that aimed to assess participants' acceptance for the Iberian wolf. Respondents were interviewed always by the same person, with a semi-structured questionnaire that consisted of two components: the first part was related to socio-demographic questions, aimed to

characterize the surveyed population (age, gender, education level and locality; Supplementary material); and the second part consisted of 26 questions divided in three groups: (i) experiences and general knowledge about wolf-related issues; (ii) opinion and general attitude towards the wolf; and, (iii) information sources where respondents gathered data about the wolf (Supplementary material). Reply options to the questions in the first group were dichotomous ("yes"/"no") and options to respond to the questions of the second group were organized on a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree" (Supplementary material). Each question of the third group included multiple choice responses, but also incorporated an option to allow an open response, when none of the options presented to the respondents were satisfactory and he/she wanted to respond differently from what was *a priori* listed (Supplementary material). Prior to the interview, we guaranteed that all data would be stored and handled anonymously, to assure that none of the answers could be linked to a specific person. This method was chosen because it allows the highest response rate of all data collection methods (Fraenkel et al., 2006), and permits the participation of individuals with lower reading and writing skills (Fraenkel et al., 2006). In addition, this approach allowed us to obtain relevant qualitative data that could not otherwise be obtained (e.g. wolf-related myths of the region), which facilitated the discussion of the results. We focused the survey on stakeholder groups whose activities may be affected by the wolf presence (i.e. hunters and livestock owners), but also on the general public. These specific groups were chosen because they are considered important players in wolf conservation in Portugal, i.e. are directly (i.e. livestock predation) or indirectly (i.e. hunting opportunities) affected by wolf presence and can constitute a lobby to effectively implement conservation plans and regulations (i.e. general public). Such an approach allows a broader view of how the full population inhabiting this region may perceive the wolf presence (Heberlein and Ericsson 2008; Muhly and Musiani, 2009; Smith and Bangs, 2009).

2.3 Data analysis

We grouped similar issue questions in order to calculate 3 scores: 1) attitude score - attitude towards the wolf; 2) knowledge score - knowledge about wolf related issues; and 3) fear score - fear of the wolf. The attitude score corresponds to the arithmetic mean of the answers to the questions related to the attitude (Question II-2, II-4, II-8, II-9, II-10, II-11 and II-12; Supplementary material). The answers to some of the questions had to be recoded to assure that positive attitudes were expressed by high values on the Likert scale and negative attitude by low values (marked with * in the Supplementary material).

For the fear score, we summed the answers related to fear and insecurity (Question II-3, II-6 and II-7; Supplementary material), culminating in a score ranging from 3 (no fear) to 15 (maximum value on the fear scale). For the knowledge score, the answers (Question I-5, I-6, I-7 and I-9; Supplementary material) were coded as dichotomous variables, using 1 for the correct answers and 0 for incorrect or missing answers. For each individual questionnaire, the answers were summed, resulting in a knowledge score ranging from 0, when none of the questions were answered correctly, to 4, when all questions were answered correctly.

We first implemented an exploratory data analysis and evaluated the differences between scores among the distinct target groups using a Kruskal-Wallis test. Later, we used a generalized linear model approach (GLM) to test what factors associated with the pre-defined hypothesis could be determining the detected patterns of attitude and fear levels, for each of the surveyed target group (Table 1). The knowledge score was used as an independent variable in both analyses.

Analyses were done using the same procedure, but separately for attitude and fear and for each target group. The answers to the attitudinal and fear-related questions (i.e. attitude and fear score) were used as dependent variables and the factors detailed in Table 1 were used as independent variables. Since each individual answered to three questions related to fear and seven related to attitude, it was necessary to consider a random factor in the GLM to account for the nested character of the data. Thus, we considered the ID of each respondent as a random factor and tested the hypothesis using generalized linear mixed models (GLMM; Zuur et al., 2009).

Since the collected data are ordinal and not independent, the model type used was a Cumulative Link Mixed Models for ordinal logistic regression. Models were produced using the package “ordinal” of software R (Christensen, 2015; R Core Team, 2015), and all the modelling procedures were the same for both analysis (i.e. attitude and fear).

Due to the low number of independent variables under test, the model building approach was based on producing models corresponding to all possible combination of all independent candidate variables. Best models selection was performed using an information-based approach (Burnham and Anderson, 2002), the Akaike Information Criterion, with a correction for small sample sizes (AICc). All models were ranked according to AICc value, and those models with a $\Delta AICc < 2$ (i.e. difference between the AICc of a model and the lowest AICc score; Burnham & Anderson, 2002) were considered the best models, i.e. retaining the most explanatory variables. When more than one model fulfilled the above-mentioned criteria, we

applied a model averaging procedure to estimate each variable average coefficient for the model that best explained the patterns of attitude and fear variation among respondents. Akaike weight (w) of each model, which corresponds to the probability of the model being the best model (Burnham and Anderson, 2002), was also calculated. This model building and selection procedure was implemented using the "MuMin" package (Barton, 2016). All variables included in the best/average model(s) produced, and whose coefficient 95% confidence intervals did not include 0 were considered influential (those for which it was possible to determine the direction of its influence on the dependent variable – positive or negative). Using this approach, it was possible to exclude non-informative parameters from the models. All data analyses were done with RStudio version 1.0.143 and R version 3.4.1 (R Core Team, 2015). For statistical tests we used $p < 0,05$ as the significance level criterion.

3. Results

3.1 Characteristics of sample

We collected a total of 371 questionnaires but only used 323 (87%) in the analysis. We excluded from the analysis questionnaires from respondents who lived outside the study area (n = 40) or those which had one or more unanswered questions (n = 8). A total of 323 questionnaires were analysed: 228 (71%) from the general public, 48 (15%) from livestock owners and 47 (14%) from hunters (this variability in sample size *per* groups expresses the differences in representativeness of each focal group within the study area). There were 189 (58.51%) male responders and 134 (41.49%) females, with an overall average age of 43 (range 16-90, n=323). Regarding the education level, the vast majority of the respondents had some type of school education. A large number of the general public group attended secondary education or higher education schools (N= 160; 70.18%). In the case of livestock farmers and hunters, we observed a different scenario, as most of them only have attended elementary schools (N=24; 50% and N=24; 51.06%). The majority of the respondents live in areas with a high number of inhabitants (>1000 inhabitants; N= 179; 55.42%), although there is a high percentage of people living in areas with smaller total population (<1000 inhabitants; N= 144; 44.58%).

3.2 Comparison of attitude, knowledge and fear patterns between target groups

The general attitude of the sampled population towards the wolf was positive, with an average score of 3.62 on the Likert scale. Our results showed that the attitude towards the wolf is significantly

different between the groups (H = 43,655; df = 2; p <0.05), with the general public showing a more positive attitude (attitude score = 3.84) than the hunters (3.12) and the livestock owners (3.1) (Figure 1).

Although knowledge regarding the Iberian wolf ecology/characteristics was also significantly different between the groups (H= 25.723; df= 2; p<0,05), a distinct pattern compared to that detected for attitudes was registered. Here, hunters showed the highest knowledge score (2,45), while livestock owners (1,65) and the general public evidenced low knowledge levels (1,62) (Figure 1). Finally, livestock owners were the group that displayed higher fear score toward the wolf (Fear score = 9.04), followed by the hunters (8.02) and the general public (7.53), but these differences were not significant (Figure 1).

3.3 Variables influencing the attitude towards the wolf

Of all the models built to assess the drivers of attitude patterns, three (N_{total}=63), four (N_{total}=256) and nine (N_{total}=63) were considered best models (i.e., ΔAICc <2) in explaining the variability in the attitude score of the general public, livestock owners and hunters towards the wolf (Table 2), respectively. These models were then used to calculate the best average model for each group.

The variables included in the best average model of general public dataset were 'education level', 'age', 'fear score' and 'number of inhabitants per locality' (Table 3). However, only for 'education level' and 'fear level' it was possible to determinate the direction of the influence on the dependent variable, since these were the only variables for which the coefficient 95% confidence interval did not include 0 (Table 3; marked in bold). So, it is possible to observe that fear is negatively associated with attitude, i.e. the higher the fear score is, the more negative the attitude towards the wolf seems to be. In the case of education level, the association was positive, i.e. people with a higher education level presented a more positive attitude towards the wolf.

In the group of livestock owners, the variables included in the best average model were 'education level', 'fear score', 'cattle losses', 'gender' and 'presence of dogs to protect livestock'. From these, we could only determinate the influence on the dependent variable (attitude) of the variables 'education level' and 'fear score', since they are the only two whose 95% CI (coefficient confidence interval) does not include 0. There seems to be a significant trend for more educated livestock owners to have a more negative attitude toward the wolf. This group's attitude towards the wolf is also negatively influenced by the fear of the species, i.e. individuals with a higher fear score presented a more negative attitude.

For the last target group, the hunters, ‘education level’, ‘fear score’, ‘knowledge score’, ‘number of inhabitants per locality’, ‘age’ and ‘knowledge of attacks on cattle by the wolf’ were the variables included in the best average model. From those, we can only infer with a high degree of certainty, the influence of the variables ‘education level’, ‘fear score’ and ‘level of knowledge’ in attitude variation. Hunters with an intermediate level of education generally have a more positive attitude in comparison with those with less academic qualifications. In addition, hunters with a higher fear score presented a more negative attitude, and, there also seems to be a tendency for hunters with a higher level of knowledge (knowledge level 3 and 4) to present a more negative attitude toward the wolf, than hunters with lower knowledge levels.

3.4 Variables influencing the fear of the wolf

We obtained two, four and five plausible models that fulfilled the criteria to be best models (ΔAICc <2) to explain the variability found in the fear scores within the general public (N_{total}=64), livestock owners (N_{total}=128) and hunters (N_{total}=64) data subsets, respectively (Table 4). Thus, we used those models to estimate the best average models.

The wolf associated fear felt by the general public was mostly influenced by the responder’s ‘educational level’, ‘gender’, ‘age’, but also by the ‘number of inhabitants per locality’ (Table 4 and 5). There was a significant tendency for older individuals to be less afraid of the wolf and for female respondents to present higher levels of fear (Table 5).

Livestock owners’ fear scores seem to be influenced by the ‘knowledge score’, ‘age’, the ‘number of inhabitants per locality’ and ‘losses of cattle’ (Table 4 and 5). Of these variables, the 'knowledge score' is the only variable for which it is possible to identify the influence’s direction on the variation of fear scores. There is a tendency for livestock owners with higher levels of knowledge regarding wolf to be less afraid of this predator than individuals of the same group with lower levels of such knowledge (Table 5).

Finally, the variables included in the best average model built for hunters were ‘knowledge of attacks on livestock made by the wolf’, ‘education level’, ‘number of inhabitants by locality’, ‘age’ and ‘gender’ (Table 4 and 5). However, only for ‘education level’ and ‘age’ of the respondents it possible to assess influence with a high degree of certainty. Thus, hunters with a higher education level and older hunters tend to show lower fear levels (Table 5).

4. Discussion

Our research highlights the importance of studying the attitudes and behaviours of the people who share the landscape with wolf populations, and have the potential to be directly affected by wolves, demonstrating that the drivers affecting both processes are group-specific. These different stakeholders include groups that are usually not considered in the discussion of conservation programs (Battisti 2017), and thus it provides insights that can guide conservation programs locally or in similar socioeconomic or cultural settings.

Generally, we found that the attitude of respondents was neutral to positive towards the Iberian wolf, highlighting that local peoples' attitude towards top predators is not always negative (Kruuk, 2002) and contradictory to wildlife, and particularly large carnivore, conservation goals. The detected pattern must be related with the low levels of livestock predation (Figueiredo et al., 2020), but probably also to the long human coexistence with this carnivore in the region (e.g. centuries). In fact, livestock predation seems to be key to the general attitude pattern. Because of high wild prey diversity and density in northeast Portugal, livestock predation is lower than elsewhere (Figueiredo et al., 2020, estimated livestock predation to be lower than 20%). This diet pattern explains why livestock owners attitude is neutral, as people do not perceive wolves as a large problem for livestock breeding. This pattern was already described in Portugal (Espírito-Santo, 2006, 2007; Milheiras and Hodge, 2011), but also in other European countries, such as Italy, especially in areas where human populations coexist with this carnivore for decades or centuries (Glikman et al., 2012). These are also areas where dogs use to guard livestock is still traditional, which is an effective approach to mitigate the conflict between wolf and livestock owners (Coppinger et al., 1983). However, while general attitude was neutral to positive, we detected differences in the attitude, and their drivers between the different stakeholders groups. The fact that the general public showed a more positive attitude towards the wolf than hunters and livestock owners is probably related with the higher probability of direct contact or experiences with this predator that the latter two groups may face, e.g. hunters, may compete for large game species and might encounter wolves in their hunting journeys; and livestock owners may face livestock depredation events (Ericsson and Heberlein, 2003; Røskaft et al., 2007). The general public attitude is most probably related with a lack of direct interactions with this predator, as most of the interviewed individuals from this group live in urban areas, and, in general, residents of larger communities have less contact with the wilderness and are more tolerant toward carnivores (Kleiven et al., 2004; Røskaft et al., 2007). As most of these group have "urban jobs" (e.g. shop-owners, police, teachers, etc.) many

stated that the wolf did not affect them negatively in any way, which supports the detected pattern. Interestingly, both hunters and livestock owners had a neutral attitude towards this endangered species, a contrasting pattern to those found elsewhere (Blanco and Cortés, 2001; Ericsson and Heberlein, 2003; Bisi et al., 2007; Røskaft et al., 2007; Bisi et al., 2010; Dressel et al., 2014; Espírito-Santo and Petrucci-Fonseca, 2014). In our study area, hunters direct their activity preferentially to small game species, such as wild rabbit (*Oryctolagus cuniculus*) and partridge (*Alectoris rufa*). Thus, the competition between hunters and the wolf for large game species is low (Røskaft et al., 2007; Bisi et al., 2010). Additionally, this endangered species diet is not dependent on livestock; livestock predation events are low in the area (Pimenta et al., 2018), a pattern corroborated by the low frequency of domestic items in the wolf diet (Figueiredo et al., unpublished data). This is probably related to the high diversity and density of wild ungulates (Santos, 2009; Valente et al., 2014; Torres et al., 2015). Indeed, pastoral activity is currently rare in the study area and the few existing domestic animals are guarded by shepherds and cattle dogs (Pimenta et al., 2005). These factors may contribute to the low depredation rate and consequent perception of conflict.

Overall, fear was also a common factor in the negative attitudes of all the groups, i.e., respondents who felt more fear of the wolf also presented a more negative attitude toward this predator. This pattern has been already widely described (Espírito-Santo, 2007; Røskaft et al., 2007; Espírito-Santo and Petrucci-Fonseca, 2014), reinforcing the importance of considering fear as a targeting factor in campaigns that aim to improve wolf's public attitudes. Older respondents showed less fear levels, contrary to other studies in Europe, which showed that older generations tend to be more negative towards large predators and are usually less supportive of their conservation than younger people (Røskaft et al., 2007; Bath et al., 2008; Kaczensky et al., 2004; Majić and Bath, 2010). These results are interesting, underlining that the cultural memory and long-lasting coexistence can improve peoples' tolerance toward wolves (Zimmermann et al., 2001; Bisi et al., 2007). Furthermore, when comparing fear levels between gender, only the general public showed a difference, with women having more fear than men, a pattern widely described (Røskaft et al., 2003; Espírito-Santo, 2007; Majić, 2007; Bath et al., 2008; Espírito-Santo et al., 2013). It is known that the perceived risk of a carnivore attack being fatal is greater for women (Treves and Naughton-Treves, 1999; Linnell et al., 2002) and women often fear not only for their own safety, but also for that of their family (Røskaft et al., 2003), which may be contributing to higher levels of fear. Although no gender differences are generally considered in conservation practice, our results suggest that while implementing conflict management or conservation projects (but see Herzog 2007), targeting women may help improve

overall attitudes towards wildlife and may have far-reaching benefits for wildlife conservation (Byers and Sainju 1994).

Other group-specific drivers may also shape fear levels, such as education and knowledge. Livestock owners with a higher level of knowledge presented less fear of the wolf, a pattern already evidenced in other studies (Espírito-Santo, 2007; Majić, 2007; Espírito-Santo et al., 2013; Majić et al., 2015). It has also been described that "first-hand" knowledge about a certain threat can help reduce fear, and greater knowledge may lead to a perception that wolves pose less danger to cattle in the region (Røskaft et al., 2003). For hunters, the level of education, and not the knowledge of wolves' ecology, is the main driver of wolf-related fear, with higher levels of education associated to less fear. A study carried out in Norway associated higher levels of education with less fear of carnivores (Røskaft et al., 2003) and several authors have stressed that higher levels of education generally result in greater nature awareness (Williams et al., 2002; Gusset et al., 2008) contributing to the reduction of fear levels. These results have important conservation implications as people who are fearful of large carnivores are less willing to pay for policies that support large carnivores (Johansson et al., 2011).

Education is an important driver that seems to play an important role in shaping positive attitudes for the majority of stakeholders, corroborating a commonly described pattern (Williams et al., 2002; Naughton-Treves et al., 2003; Kleiven et al., 2004; Espírito-Santo et al., 2013; Dressel et al., 2014; Suryawanshi et al., 2014). High levels of education were associated with more favourable attitudes among the general public and hunters. Higher levels of education often results in a greater awareness of wildlife protection laws and the conservation value of these carnivores (Zimmermann et al., 2005; Gusset et al., 2008), contributing to higher tolerance (Kleiven et al., 2004). However, some studies have showed that providing information about the wolf might not be enough to improve the attitudes of hunters with a more negative attitude (Ericsson and Heberlein, 2003), and this must be considered when carrying out awareness campaigns. However, livestock owners showed the opposite trend, with higher level of knowledge not guaranteeing favourable attitudes. While higher education levels seems to help improve attitudes toward wolves, and because livestock owners experience relatively low levels of livestock losses, other factors may override this driver, such as fear.

Apart from fear and education levels other stakeholder-specific drivers influence peoples attitude towards the wolf. Our results show that knowledge about the wolf was low among the population, a pattern previously described in Portugal (Espírito-Santo, 2007; Espírito-Santo et al., 2013; Espírito-Santo &

Petrucci-Fonseca, 2014) and elsewhere (Bath, 2000; Blanco and Cortés, 2001). However, knowledge negatively influenced the attitude of hunters, similar to the results found in Sweden (Ericsson and Heberlein, 2003). Although previous research has demonstrated that increased knowledge about endangered species results in positive attitudes and higher support for their conservation (e.g., Bath et al., 2008; Balčiauskas et al., 2010; Glikman et al., 2012) in the case of highly controversial species, such as the wolf, this link may not always be observed (Kellert et al., 1996; Majić and Bath, 2005; Lescureux and Linnell, 2010). Apparently, hunters experience with the species affected their attitude more sharply than knowledge. Increased knowledge can sometimes provide a basis for rationalizing and reinforcing previous (positive or negative) attitudes, rather than a cause for changing those attitudes (Kellert, 1994). Human's attitudes and fear towards wolves are generally tied to myths and stereotypes present in the subconscious of the human mind (Álvares, 2006; Jürgens and Hackett, 2017), which can ultimately undermine conservation programs (Ceríaco, 2012). In Portuguese rural communities, there is a rich ethnographic heritage regarding the wolf, expressed in legends and myths (Álvares et al., 2011). It is interesting that from all the respondents who felt fear of the Iberian wolf, 62% mentioned that this was rooted in ancient myths or stories and not in real threats or direct experience. Additionally, ancient myths and stories were also the second most chosen option by respondents when asked for their main sources of information regarding wolf. The existence of myths, fears and beliefs seems to exert a negative influence on the peoples' attitude indicating that it is fundamental to take the cultural representation of the wolf developing conservation programs.

5. Conclusion

This study demonstrates education, knowledge, and level of fear were strong predictors in explaining attitudes towards this endangered species and were broadly similar to those mentioned in studies conducted elsewhere in Europe, suggesting the broad generality of these patterns. Local communities' support for carnivore conservation efforts and tolerance of species presence are key factors for carnivore conservation success but the different stakeholder perceptions needs to be used to target future conservation actions to facilitate the development of tolerance-promoting strategies. Increasing locals' tolerance towards the Iberian wolf can be achieved by participatory target education interventions, where the stakeholders can take part in discussions to accommodate their needs and expectations, rather than passive in the implementation of programs (Jacobson et al., 2015). This will diminish the likelihood of discord between

local communities and the conservation agencies striving to secure the future of endangered carnivores and, ultimately, help to achieve long-term human-carnivore coexistence.

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Conflicts of interest

None.

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Table 1 – Factors used as independent variables in the GLM procedure to assess the drivers determining attitudes and fear levels variation within the different target groups

*Variable only used in the analysis of factors that may be affecting the attitude.
**Variable not used in the analyses of livestock owner's data.
***Variables only used in the analyses of livestock owner's data.

Acronym	Variable name	Variable description
AGE	Age	Age (Continuous values)
GENDER	Gender	1) Male 2) Female
SCHOOL	Education level	1) No school education 2) Elementary school 3) Secondary school 4) University 5) No information
POPULATION	Population	Total number of inhabitants by place of residence of the respondent: 0) <1000 inhabitants 1) ≥1000 inhabitants
KNOWLEDGE	Knowledge score	Score ranging from 0 to 4
FEAR*	Fear score	Score ranging from 3 to 15
ATTACKS**	Knowledge of attacks	Knowledge of attacks on domestic animals? 0) No 1) Yes
LOSSES***	Loss of domestic animals	Predation of domestic animals by wolves 0) No 1) Yes
DOGS***	Guardian dogs	Ownership of livestock guardian dogs 0) No 1) Yes

Table 2 - Best Cumulative Link Mixed Models produced for each target group to assess the factors influencing the attitude towards the wolf, ranked according to their AICc values df - degree of freedom; LogLik - log-likelihood; AICc - Akaike Information Criterion corrected for small samples; ΔAICc - difference between the lowest AICc score and the model's AICc score; w (Akaike weight) - relative likelihood of a model; variables acronym in Table 1)

	df	LogLik	AICc	ΔAICc	w
General population					
SCHOOL+FEAR	9	-1771.653	3561.4	0.00	0.332
SCHOOL+FEAR+AGE	10	-1771.413	3563.0	1.54	0.154
SCHOOL+FEAR+POPULATION	10	-1771.491	3563.1	1.70	0.142
Livestock owners					
SCHOOL+FEAR	9	-436.516	891.6	0.00	0.089
SCHOOL+FEAR+LOSSES	10	-435.824	892.3	0.74	0.062
SCHOOL+FEAR+GENDER	10	-436.056	892.8	1.21	0.049
SCHOOL+FEAR+DOGS	10	-436.149	893.0	1.39	0.044
Hunters					
SCHOOL+FEAR	8	-386.746	789.9	0.00	0.148
SCHOOL+FEAR+POPULATION	9	-385.820	790.2	0.26	0.130
SCHOOL+FEAR+ KNOWLEDGE	11	-383.951	790.7	0.79	0.100
SCHOOL+FEAR+POPULATION+ KNOWLEDGE	12	-382.997	791.0	1.04	0.088
SCHOOL+FEAR+ KNOWLEDGE+AGE	12	-383.204	791.4	1.45	0.072
SCHOOL+FEAR+POPULATION+ KNOWLEDGE+AGE	13	-382.151	791.5	1.52	0.069
SCHOOL+FEAR+AGE	9	-386.532	791.6	1.69	0.064
SCHOOL+FEAR+ATTACKS	9	-386.623	791.8	1.87	0.058
SCHOOL+FEAR+POPULATION+ AGE	10	-385.563	791.8	1.88	0.058

Table 3 – Variables that best explain the variability in attitude scores towards the wolf within each target group (the variables whose confidence interval at 95% of the coefficient does not include zero are presented in bold).

Variable	*β*	SE	Z Value	p	95% CI
General population					
SCHOOL (2)	1.785	1.243	1.437	0.151	-0.650/4.221
SCHOOL (3)	**2.492**	**1.240**	**2.009**	**<0.05**	**0.061/4.922**
SCHOOL (4)	**3.472**	**1.243**	**2.793**	**<0.01**	**1.35/5.908**
SCHOOL (5)	1.043	1.348	0.774	0.439	-1.599/3.686
FEAR	**-0.498**	**0.044**	**11.263**	**<0.001**	**-0.584/-0.411**
AGE	-0.002	0.005	0.294	0.769	-0.025/0.012
POPULATION	0.039	0.161	0.242	0.809	-0.420/0.764
Livestock owners					
SCHOOL (2)	**-2.487**	**0.901**	**2.762**	**<0.01**	**-4.253/-0.722**
SCHOOL (3)	**-2.364**	**0.945**	**2.502**	**<0.05**	**-4.216/-0.512**
SCHOOL (4)	-0.954	1.112	0.858	0.391	-3.133/1.226
SCHOOL (5)	**-2.656**	**1.183**	**2.245**	**<0.05**	**-4.975/-0.337**
FEAR	**-0.417**	**0.074**	**5.638**	**<0.001**	**-0.561/-0.272**
LOSSES	-0.132	0.318	0.416	0.678	-1.393/0.343
GENDER (F)	0.097	0.297	0.327	0.744	-0.500/1.472
DOGS	0.071	0.244	0.289	0.773	-0.500/1.274
Hunters					
SCHOOL (3)	**2.150**	**0.497**	**4.328**	**<0.001**	**1.176/3.123**
SCHOOL (4)	0.704	0.368	1.913	0.056	-0.017/1.425
SCHOOL (5)	-0.728	0.576	1.264	0.206	-1.857/0.401
FEAR	**-0.545**	**0.089**	**6.091**	**<0.001**	**-0.720/-0.370**
POPULATION (1)	0.194	0.304	0.638	0.524	-0.182/1.066
KNOWLEDGE (2)	-0.313	0.450	0.695	0.487	-1.529/0.031
KNOWLEDGE (3)	**-0.319**	**0.451**	**0.708**	**0.479**	**-1.515/-0.012**
KNOWLEDGE (4)	**-0.536**	**0.729**	**0.735**	**0.462**	**-2.385/-0.185**
AGE	-0.004	0.009	0.435	0.663	-0.035/0.012
ATACKS	-0.011	0.093	0.121	0.903	-0.758/0.453

β - Coeficients; SE - Standard Error; Z Value - Z value test score; p - Significance; 95% CI - 95% Confidence interval

Table 4 - Best Cumulative Link Mixed Models produced for each target group to assess the factors influencing the fear levels of the respondents, ranked according to their AICc values.

	Df	LogLik	AICc	ΔAICc	w
General population					
SCHOOL+GENDER+AGE	10	-977.573	1975.5	0.00	0.324
SCHOOL+GENDER+AGEE+ POPULATION	11	-977.114	1976.6	1.15	0.183
Livestock owners					
KNOWLEDGE+POPULATION	8	-221.609	460.3	0.00	0,074
KNOWLEDGE	7	-222.838	460.5	0.21	0,066
KNOWLEDGE+POPULATION+AGE	9	-221.040	461.4	1.14	0,042
KNOWLEDGE+LOSSES	8	-222.532	462.1	1.85	0.029
Hunters					
ATTACKS+SCHOOL+AGEE	8	-178.446	374.0	0.00	0.180
SCHOOL+AGE	7	-179.985	374.8	0.83	0.119
ATTACKS+AGEE	5	-182.595	375.6	1.65	0.079
ATTACKS+SCHOOL+AGE+ GENDER	9	-178.244	375.9	1.88	0.070
ATTACKS+SCHOOL+AGE+ POPULATION	9	-178.255	375.9	1.90	0.069

df - degree of freedom; LogLik - log-likelihood; AICc - Akaike Information Criterion corrected for small samples; ΔAICc - difference between the lowest AICc score and the model's AICc score; w (Akaike weight) - relative likelihood of a model; variables acronym in Table 1).

760 **Table 5** – Variables that best explain the variability in fear scores towards the wolf within each
761 target group (the variables whose 95% confidence interval of the coefficient does not include zero
762 are presented in bold).

Variable	*β*	SE	Z Value	p	95% CI
General population					
SCHOOL (2)	-1.063	1.337	0.794	0.427	-3.684/1.559
SCHOOL (3)	-2.079	1.339	1.553	0.121	-4.703/0.545
SCHOOL (4)	-2.588	1.331	1.944	0.052	-5.197/0.021
SCHOOL (5)	-0.314	1.441	0.218	0.828	-3.138/2.511
GENDER (F)	**0.679**	**0.253**	**2.684**	**<0.01**	**0.183/1.175**
AGE	**-0.032**	**0.010**	**3.303**	**<0.001**	**-0.051/-0.013**
POPULATION (1)	0.111	0.243	0.457	0.648	-0.321/0.936
Livestock owners					
KNOWLEDGE (1)	-0.782	0.678	1.143	0.253	-2.123/0.559
KNOWLEDGE (2)	**-1.553**	**0.679**	**2.268**	**<0.05**	**-2.895/-0.211**
KNOWLEDGE (3)	-1.446	0.821	1.745	0.081	-3.071/0.178
KNOWLEDGE (4)	**-2.658**	**1.039**	**2.537**	**<0.01**	**-4.711/-0.604**
POPULATION (1)	-0.380	0.468	0.809	0.419	-1.538/0.148
AGE	-0.002	0.006	0.341	0.734	-0.029/0.009
LOSSES	0.033	0.139	0.235	0.815	-0.361/0.833
Hunters					
ATTACKS	0.508	0.419	1.205	0.228	-0.049/1.368
SCHOOL (3)	**-1.112**	**0.700**	**1.581**	**0.114**	**-2.423/-0.200**
SCHOOL (4)	**-0.698**	**0.460**	**1.508**	**0.131**	**-1.580/-0.066**
SCHOOL (5)	-0.091	0.629	0.144	0.886	-1.455/1.240
AGE	**-0.039**	**0.013**	**2.914**	**<0.01**	**-0.065/-0.013**
GENDER (2)	-0.064	0.317	0.200	0.841	-1.938/0.996
POPULATION (1)	0.033	0.168	0.195	0.846	-0.540/1.029

763 *β* - Coeficients; SE - Standard Error; Z Value - Z value test score; p - Significance; 95% CI - 95%
764 Confidence interval
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767
768
769